PACIFIC NORTH WEST
U. S. FOREST SERVICE
Research Note
FOREST AND RANGE EXPERIMENT STATION · U.S. DEPARTMENT OF AGRICULTURE · PORTLAND, OREGON

PNW-34 January 1966

BARK FACTORS FOR DOUGLAS-FIR

by

Floyd A. Johnson

Recent emphasis on the measurement of upper stem tree diameters with optical dendrometers[1/] has directed attention to procedures for converting these outside-bark diameters to inside-bark diameters.

One procedure that has been used requires an assumption that the ratio of diameter inside bark to diameter outside bark (henceforth called bark factor) remains the same up the stem. If this is true, bark factor measured at some reachable point on the lower stem (e.g., 4.5 feet) could be applied to diameter outside bark at any point on the upper stem to estimate diameter inside bark at that point. Thus

$$d_i = d_o B_{LS} \qquad (1)$$

where d_i = diameter inside bark at any point on the upper stem

d_o = diameter outside bark at the upper stem point

B_{LS} = lower stem bark factor

Equation 1 may be satisfactory for some tree species, but a regression analysis has indicated that upper stem and lower stem bark factors are not the same on young-growth Douglas-fir trees.

[1/] Grosenbaugh, L. R. Some suggestions for better sample tree measurement. Soc. Amer. Foresters Proc. 1963: 36-42.

Data from 540 trees were used in this analysis. Six basic independent variables were recorded for each tree along with a single upper stem bark factor (i.e., the dependent variable) which was taken at varying distances up the stem. The six basic independent variables were:

L = distance up the stem from ground

A = tree age

D = diameter at breast height outside bark

H = total tree height from ground to tip

d_o = diameter outside bark at a point on the upper stem where the upper stem bark factor was taken

B_{LS} = bark factor at stump

The 540 trees used in this study ranged from 13 to 143 years in age and from 2 to 40 inches in outside-bark diameter at breast height. They are believed to be reasonably representative of the young-growth timber type in western Oregon and western Washington.

Stump bark factor was used as an independent variable in the analysis merely because bark factor at 4.5 feet was not available. Perhaps it can be assumed that bark factor at 4.5 feet and bark factor at stump would have been approximately the same.

The regression analysis led to the following equation:

$$B_{US} = \left[6931 - 2.5A + 10.6D - 311(L/H)^2 + 1343(L/H)(d_o/D) + 2326B_{LS}\right]10^{-4} \quad (2)$$

where B_{US} = upper stem bark factor

Better estimates of upper stem, inside-bark diameters should result if B_{US} is used to replace B_{LS} in equation 1. This would be facilitated by an electronic computer because equation 2 is rather unwieldy.

If total height (H) is not available as a predictor variable, either because it is too difficult to measure or for some other reason, equation 2 cannot be used, and equation 3 will then be appropriate:

$$B_{US} = \left[6194 - 2.6A + 3.2L + 2378(d_o/D) - 1545(d_o/D)^2 + 2533B_{LS}\right]10^{-4} \quad (3)$$

Equation 4 can be used if both tree age and total height are unavailable:

$$B_{US} = \left[5590 + 0.6L + 2030(d_o/D) - 1542(d_o/D)^2 + 3413B_{LS}\right]10^{-4} \text{ - - - - -(4)}$$

Percentages of the total bark factor variation accounted for were 40 by equation 2, 37 by equation 3, and 27 by equation 4.

When equations 2, 3, and 4 were applied to an 80-year-old Douglas-fir tree which had a breast-high bark factor of 0.90, a breast-high diameter outside bark of 20.9 inches, a total height of 131 feet, and a series of measurements, L and d_o, up the stem, the following results were obtained:

L	d_o	Bark factor			Diameter inside bark (inches)			
		Equation 2	Equation 3	Equation 4	Equation 2	Equation 3	Equation 4	Equation 1
18.3	17.6	0.9198	0.9231	0.9289	16.2	16.2	16.3	15.8
30.5	16.7	.9279	.9277	.9318	15.5	15.5	15.6	15.0
46.1	15.0	.9347	.9324	.9352	14.0	14.0	14.0	13.5
60.7	13.7	.9388	.9356	.9367	12.9	12.8	12.8	12.3
82.5	11.3	.9381	.9364	.9358	10.6	10.6	10.6	10.2
94.5	9.3	.9315	.9321	.9317	8.7	8.7	8.7	8.4
104.7	7.3	.9222	.9242	.9245	6.7	6.7	6.7	6.6